5 Ecological Restoration

When natural resources in the national parks become damaged and degraded, resource managers turn to restoration as a way to repair ecosystems and return

native species and natural processes to the landscape. Restoration essentially takes the next step after eliminating the cause of the problem: removing nonnative species, cleaning up pollution, stopping illegal activities or inappropriate park uses, and others. It attempts to reestablish natural function where it was hampered so that park ecosystems can sustain themselves once again. The efforts to achieve these goals, as many of the articles in this chapter illustrate, go beyond making

mechanical changes in landforms and technical arrangements of species in a particular setting.

> *"Like the preservationist, … the restorationist aims for the ideal of a self-sufficient ecosystem, doing everything possible to let the system be, to turn it back into itself. Unlike the preservationist, however, the restorationist recognizes that the ideal of nature separate from humans "is a fiction."* — **William R. Jordan, III**

They integrate research to understand natural processes and relationships among the resources, and how each has been influenced by land use history. They demonstrate teamwork in project execution that incorporates creativity and precision. Moreover, they share ways in which people—National Park Service

staff, partners, contractors, and volunteers—apply many of these principles to restore natural integrity and function to damaged natural areas in the parks. Though for every project described herein many more are undoubtedly needed, the following stories give hope for a National Park System that will retain its special character, diversity, and appeal, and even take on

new meanings.

Coastal dune restoration at Point Reyes pays off for three federally listed species

By Jane Rodgers and Dawn Adams

URBANIZATION AND INVASIVE NONNATIVE PLANTS have fragmented and eliminated coastal dune habitats. Along the west coast of the United States, coastal dunes are just 10% to 40% of their original distribution, according to ecologists. The problem has become so severe that whole communities of species that consistently occur together—invertebrates, birds, and plants—are now listed as threatened and endangered. To reverse this trend, Point Reyes National Seashore in California has cleared approximately 45 acres (18 ha) of dunes of European beachgrass (*Ammophila arenaria*) and other invasive plants as of FY 2005 to restore natural processes and improve habitat for federally listed species. By the end of the calendar year, monitoring results showed that dune restoration has paid off for at least three species listed as threatened or endangered.

In partnership with Point Reyes Bird Observatory Conservation Science, a park partner, the national seashore has monitored the threatened western snowy plover (*Charadrius alexandrinus nivosus*) since 1986. Dunes altered by invasive plant species restrict plover nesting to a narrow strip of sand between the beachgrass-formed seawall and the high tide line. Removing the beachgrass creates open space, providing chicks with large, navigable areas to forage, avoid predators, and stay away from human disturbance. Plover chicks are camouflaged in open sandy areas with their light, speckled coloring; well-placed driftwood spread by volunteers provides additional hiding places for the vulnerable young birds. Since March 2004, three nests have been discovered in restored dunes, the first ever seen in these areas. In 2005, following additional beachgrass removal, biologists documented male plovers moving chicks into restored areas for rearing purposes from nests as far away as 1.5 miles (2.4 km). More than half of the chicks fledged in the 2005 breeding season were reared in the restored sites.

Nine species of native dune plants have reappeared within the restored area, making active revegetation unnecessary.

In the spring the two endangered dune plants, Tidestrom's lupine (*Lupinus tidestromii*) and beach layia (*Layia carnosa*), naturally recolonized newly restored sites. In an area recently restored using heavy equipment, nearly 200 lupine and 18 layia seedlings were growing, presumably from newly exposed seed. Nine species of native dune plants have reappeared within the restored area, making active revegetation unnecessary.

Urbanization and nonnative plants have reduced coastal dune habitats to 10% to 40% of their original distribution along the west coast of the United States. As of FY 2005, Point Reyes National Seashore has cleared approximately 45 acres (18 ha) of dunes of European beachgrass and other nonnative plants to restore natural processes and improve habitat for federally listed species.

The Pacific Coast population of the western snowy plover has been federally listed as threatened since 1993. Restored dunes at Point Reyes National Seashore have improved habitat for the plover. More than half of the chicks fledged in the 2005 breeding season were reared in sites cleared of nonnative plants.

The dune restoration effort has taken four years and relied on support from the Natural Resource Preservation Program and Natural Resource Damage Assessment Program (NRDA) oil spill funds. Monitoring of pre- and postrestoration conditions has been a critical measure of project success. The data for listed species show that, "if you build it, they will come," and indeed they did. The early positive results have encouraged the national seashore to expand dune restoration activities. Point Reyes National Seashore will embark on an ambitious effort to restore 300 acres (122 ha), which represents approximately half of the dunes in need of restoration. Funds for the expanded restoration activities will be contributed by the NRDA, local nonprofits, and the NPS line-item construction program. The timing could not be better. ■

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Collaboration key to Snake River embankment restoration at Grand Teton

By Susan E. O'Ney

IN 2005, GRAND TETON NATIONAL PARK coordinated a successful collaborative effort to stabilize a section of the Snake River near its park headquarters in Moose, Wyoming, using state-of-the-art bioengineering techniques. In response to 1997 flood conditions, the west bank of the river eroded as much as 5 feet (1.5 m), which caused concern for park facilities. This area is highly visible to park visitors and offered a great opportunity to design an informative demonstration project, illustrating the use of innovative restoration and stabilization techniques in lieu of the typical bank armoring. The techniques used to restore area riparian vegetation and fish habitat included a combination of brush and rock barbs, vertical willow bundles, brush revetments (retaining walls made of brush), pole plantings, and brush mattresses. In a park setting, these techniques are much more appropriate (not to mention more aesthetically pleasing) than armoring the banks with large boulders, as had been done in the past.

The success of this project was due largely to successful partnerships and collaboration. Funding came from a combination of sources, including the National Park Service Cooperative Conservation Initiative ($10,000), Grand Teton National Park Franchise Fee ($100,000), Jackson Hole One-Fly ($5,000), and Teton County Conservation District ($5,000 in-kind). The Natural Resource Conservation Service provided the expertise to design and implement bioengineering techniques to restore riparian vegetation. In-kind participation of park personnel was critical to the collection of native materials and project supervision and oversight.

This area … offered a great opportunity to … use … innovative restoration and stabilization techniques.

In May 2005 the park conducted a three-day Riparian Ecology and Restoration Workshop at the restoration site. During the first half of the workshop, attendees participated in classroom exercises. During the second half of the workshop, attendees, other community volunteers, and personnel from neighboring agencies and sister parks completed the hands-on bank stabilization work. The Teton County Conservation District provided lunch for attendees, handled workshop logistics, and coordinated collection of native plant materials, including logging slash for the brush revetments and live willow cuttings. Collected by volunteers from the Teton Science School, the willow cuttings provided the materials for the vertical bundles, brush barbs, pole plantings, and brush mattress.

Results have been spectacular. Plantings experienced a 95% success rate and sediment deposition is rapidly occurring along the riverbank. Streambank vegetation, bank stability, fish habitat, and aesthetics have all been improved along this reach of the Snake River. This project is an outstanding example of how innovative streambank bioengineering techniques could be used in similar situations throughout the National Park System. ■

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To stabilize the west bank of the Snake River, Grand Teton National Park cooperated with numerous organizations and agencies: the Teton County Conservation District; the Teton Science School; the Natural Resource Conservation Service (NRCS) National Design Construction and Soil Mechanics Center in Fort Worth, Texas; the NRCS Plant Materials Center in Aberdeen, Idaho; the NRCS in Casper, Wyoming; Rendezvous Engineering (a local engineering firm); Grand Teton Lodge Company (a park concessionaire); Jackson Hole One-Fly; and the National Fish and Wildlife Foundation. Here, workshop participants are installing a brush mattress from live willow stakes to protect the streambank from erosion.

Success! Sediment deposition along the brush revetment (left) and willow growth from pole plantings and vertical bundles (right) offer a more gentle slope along the west bank of the Snake River at Moose, Wyoming, after the stabilization and restoration project.

First-time restoration prompts return of seagrass to Biscayne National Park

By Kim Olsen and Tammy Whittington

WETLAND RESTORATION may be a familiar if technical activity of the National Park Service on terra firma, but imagine restoring vegetation on the ocean floor! Until recently the National Park Service had never attempted this kind of restoration. However, vessels running aground in shallow waters of Biscayne National Park (Florida) have damaged plants known as seagrass in several park locations, necessitating a plan for their restoration. Seagrass includes turtle grass (*Thalassia testudinum*) and shoal grass (*Haldule wrightii*) and serves an important function as nurseries for fish and other marine life. Injuries to these native plants occur when boat operators attempt to power off or free themselves from their predicament, and in the process propellers create trenches and "blowholes" in the delicate ocean floor material where seagrass grows. In 2002 and 2004 the National Park Service and its partners restored three sites where seagrass had been injured by boat groundings. By May 2005, signs of recovery were evident, signaling a breakthrough for the National Park Service in this new restoration activity.

The restoration sites were named for the three vessels that had injured the seagrass: *Pure Pleasure, She's a Lady,* and *Tom's Tug.* Authorized by the National Park System Resource Protection Act (16 USC 19jj), the National Park Service has been able to recover damages from the responsible parties to fund the restoration. The restoration process began in September 1999 when a multidisciplinary team from Biscayne National Park, the Restoration Unit of the NPS Environmental Quality Division, and contractors from Tetra Tech EC, Inc., and Marine Resources, Inc., planned the project. The group determined its scope, acquired permits, and defined criteria for evaluating success. The Final Restoration Plan (December 2003) guided the restoration based on the type of injury at each site, and the Final Completion Report (October 2004) documents the methods.

By May 2005, signs of recovery were evident, signaling a breakthrough for the National Park Service in this new restoration activity.

The Pure Pleasure site consisted of two propeller scars. The restoration team backfilled the site with approximately 1 cubic yard (0.8 cu m) of sediment, which was batch-mixed by a concrete mixer and shoveled into 45 burlap bags. The sediment included fine silica sand, diatomaceous earth, calcium carbonate sand, and an organic material added at 5% by weight. After placing the bags into the trenched areas, the team slit them to allow water to flow freely around them and distribute the sediment. In June 2005 the

By May 2005 the site was beginning to recover with new seagrass growth visible around "bird" stakes. The stakes were placed to encourage roosting and natural fertilization of the restoration site by waterbirds.

Seagrass restoration at Biscayne National Park involved placement of sediment-filled burlap bags in trenches where powerboats had run aground and their operators had attempted to free themselves from shallow water. The Tom's Tug site is the largest of three restoration areas and is shown immediately after placement of the bags in June 2004.

By May 2005 a transplanted seagrass plug had begun to recruit new growth at the restoration site.

site had stabilized, the burlap had begun to degrade, and natural recruitment of shoal grass was documented to approximately 15% cover.

Restoration of the She's a Lady site was similar and required backfilling three propeller scars. The sediment material used at this site consisted of calcium carbonate sand, lake fill, masonry sand, and organic material added at 7% by weight. The mixture was loaded into approximately 140 burlap bags, totaling 3.1 cubic yards (2.4 cu m), which the contractor placed into the trenches, again slitting them on the sides. In addition, they placed 13 "bird" stakes and two "No Boating" signs at the site. The stakes are intended to encourage waterfowl roosting and the deposition of natural fertilizer onto the restored areas. In May 2005 the injured areas had recovered to about 5% turtle grass and 15% shoal grass cover. Although this site was located in an area of strong current and extreme wave action, restoration was successful.

The Tom's Tug blowhole was the largest restoration site and required 375 bags of sediment, or 8.4 cubic yards (6.4 cu m), placed in the same manner and with the same mixture as at the She's a Lady site. Six bird stakes and one "No Boating" sign were also installed. Approximately 45 days after the sediment-filled burlap bags settled into the trenches, the team harvested 42 plugs of turtle grass from a nearby healthy seagrass bed for transplanting at 1.6-foot (0.5 m) intervals throughout the injured site. In May 2005 the project team was elated to discover large areas of new plant growth and survival of the transplanted seagrass plugs. The burlap bags have degraded and the area is now about 70% covered with the turtle grass, recruited shoal grass, and manatee grass (*Syringodium filiforme*).

These three seagrass restoration projects are the first for the National Park Service. Though they appear to be successful, the sites will continue to be monitored. Planning was strenuous and time-consuming; however, the field results for restoring this critical habitat have proven to be very encouraging, and the planning documents are now being used to guide restoration of other seagrass sites in the park. ■

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Joshua Tree National Park disguising closed roads to protect fragile desert ecosystems

By Paul DePrey and Margaret Adam

SOMETIMES OLD ROADS ARE MORE INVITING than the National Park Service would like, especially in fragile desert ecosystems where they remain visible for decades after they are closed. By 2005, Joshua Tree National Park, located in the heart of the desert in southern California, had successfully "disguised" miles of closed dirt roads, effectively deterring unwanted and illegal use that slows down the natural restoration process.

Many roads in the national park, most left over from historical mining and homesteading activities, were closed to motorized use when Congress designated the area as wilderness in 1994. Where these old roads are still visible, some people continue to use them. This is especially true where boundary marking is unclear (leading to confusion) or where ranger patrols are intermittent (leading to temptation). Whatever the reason, this activity reinforces the visible scar, prevents revegetation, contributes to erosion, and may lead to new damage to park resources.

Stopping illegal traffic prevents damage and allows natural revegetation to progress.

Nearly 150 roads are closed within the park, ranging from tracks nearly obliterated by natural regrowth to areas repeatedly marred by illegal off-highway vehicle use. Management in this area consists of two primary goals: protecting resources and stopping illegal driving. To achieve these objectives the strategy is to obliterate the appearance of roads in order to reduce the visual scar and eliminate the temptation to drive on them. Stopping illegal traffic prevents damage and allows natural revegetation to progress. This helps restore the natural plant community and decrease erosion.

The most effective technique for disguising closed roads at Joshua Tree National Park is vertical mulching. This process involves planting dead vegetation (taken from nearby areas) to simulate living shrubs. In addition to blocking access, the technique encourages natural regrowth by providing shelter from sunlight and protection from wind for seeds and seedlings. Other road-closing techniques are installation of posts or fencing, strategic placement of boulders, planting seeds, transplanting existing plants, recontouring the road surface, and scattering rocks along it.

Managers have developed a protocol to help them determine the effectiveness of vertical mulching in restoring the fragile Mojave and Colorado Desert ecosystems within the park. This protocol includes using belt transects (surveying the area at regular intervals) to measure the amount and type of species that occur within the area. It also includes testing soil crust for structural integrity and comparing treated and untreated areas. Initial monitoring visits have been completed at more than a dozen sites and will continue at sites in each of the vegetation communities in the park.

Old roads at Joshua Tree National Park are being rehabilitated to disguise or clearly mark them as closed so they will not be mistaken as legitimate driving routes. Park staff has applied a technique of "vertical mulching," or planting dead vegetation and spreading rocks, so that barren areas will blend into their desert surroundings and begin the process of natural revegetation. Boulders and "no motor vehicles" signposts are also employed as needed.

By 2005, more than 120 sites were successfully rehabilitated. In addition, following a process to identify sensitive cultural resources, park staff has secured clearance to add a dozen more sites to the program. Periodic visits to these rehabilitated sites have revealed few incidences of trespass or damage, indicating that the disguise is working and that the program is effectively ending the "invitation" to drive over fragile, but now healing, park resources. ■

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Ladders, lint, bridges, and rubble: Cleaning up Carlsbad Cavern

By Paul Burger

WITH THE HELP OF VOLUNTEERS AND PARTNERS in 2005, park staff removed six structures, more than 20 tons (18 metric tons) of rubble, and many pounds of lint from Carlsbad Cavern, New Mexico. More than 100 years of trail development and visitation had severely altered the natural cave ecosystem. Past workers had buried more than 7,500 square feet (698 sq m) of natural cave floors with rubble from the construction of the underground lunchroom and the two elevator shafts that were blasted into the cave. This rubble, along with rock and dirt removed from other areas of the cave, was used to fill in low areas. However, it buried the natural cave floors and altered the habitat of the invertebrates and other cave animals that lived there. In some off-trail areas, the National Park Service had placed more than a dozen ladders and bridges to make travel easier. Wooden structures increased nutrient levels in the normally nutrient-poor cave system, resulting in overpopulation of cave crickets, other invertebrates, and microbes. Deteriorating steel structures introduced metals, which are harmful to native microbes, invertebrates, and other cave animals. In addition, around 350,000 annual cave visitors continue to deposit foreign materials such as lint, hair, paper, and food along the trail system. As these materials decompose, they create chemicals that damage and discolor cave formations.

More than 100 years of trail development and visitation had severely altered the natural cave ecosystem.

With a grant from the Cooperative Conservation Initiative and more than 2,000 volunteer hours, reversal of these impacts has begun. Grant monies have allowed park managers to purchase stainless-steel ladders, which do not add metals to the cave environment, and safety equipment for volunteers. Volunteers and staff, using shovels and wheelbarrows, removed tons of rubble, restoring more than 800 square feet (74 sq m) of natural cave floor. Workers dismantled and carried away one large, old wooden bridge and five steel walkways from selected areas of the cave—nearly half of the structures identified for removal. Resource specialists targeted structures and areas where continued deterioration was most pronounced and where highly qualified volunteers could be most effective. Many of the structures were in densely decorated areas of the cave, requiring technical skills for their removal without damaging the fragile cave formations or causing injury to workers. Additionally, volunteers used brushes and tweezers to painstakingly extract lint, hair, and other materials dropped in the cave by visitors.

Walkway area before and after restoration.

These efforts have resulted in restoration of approximately 10% of disturbed cave floor and habitat in the area around the old underground lunchroom. Volunteers and staff have minimized deterioration of cave decorations and walls along trails where they removed lint and trash. In addition, their labors have eliminated the primary sources of contaminants in off-trail areas of the cave, comprising nearly half the areas where deteriorating structures had been. These efforts are a tremendous start to the process of reversing some of the damage caused by infrastructure and visitation and of restoring habitat in Carlsbad Caverns National Park. ■

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Diversifying bighorn sheep genetics at Badlands National Park

By Eddie Childers and Teresa Zimmerman

THE FIRST-GENERATION PROGENY of recently introduced and resident bighorn sheep at Badlands National Park, South Dakota, were born in spring 2005. In fall 2004, staff at Badlands, in cooperation with the South Dakota Department of Game, Fish, and Parks and the New Mexico Department of Game and Fish, captured and relocated to the park 23 bighorn sheep (10 adult ewes, 2 yearling ewes, and 11 lambs) from Wheeler Peak, New Mexico. These sheep are now helping repopulate the historical eastern range (i.e., parts of Montana, Wyoming, the Dakotas, and Nebraska) of the Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) that had been extirpated throughout much of this area by 1925. As of December 2005, 9 of 11 lambs were alive.

North American bighorn sheep are an ecologically fragile species. Human impacts over the last 150 years have led to major decreases in populations. Factors of decline include overgrazing, diseases introduced by cattle and domestic sheep, urban expansion, mining, logging, off-road vehicle use, unregulated hunting, competition with mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*), oil and gas exploration, usurpation of water resources, and fire suppression.

In order to restore genetic diversity, scientists recommended population supplementation from another herd of Rocky Mountain bighorn sheep.

In 1964, to restore this native ungulate to its former range, the National Park Service; the South Dakota Department of Game, Fish, and Parks; and the Colorado Division of Wildlife introduced 20 Rocky Mountain bighorn sheep from Pikes Peak, Colorado, to a 370-acre (150 ha) enclosure at Badlands. The goal of the project was to establish a captive breeding herd, which would allow relocation to other areas of suitable habitat in South Dakota. However, disease reduced the captive herd to 14 animals, which were then released into the park. The herd grew rapidly, but over the next 30 years a series of three diseases (epizootics) reduced the population from its peak of more than 140 individuals to fewer than 60.

Based on the estimated effective population size and the analysis of molecular genetic data, biologists determined that the bighorn sheep at Badlands had undergone a "population bottleneck" at founding. In order to restore genetic diversity, scientists recommended population supplementation from another herd of Rocky Mountain bighorn sheep. This led to the translocation in 2004, which is intended to provide both short- and long-term genetic contributions to the Badlands population.

With support from Badlands National Park, a PhD student from South Dakota State University has been monitoring the introduced animals since their arrival from New Mexico. The study is evaluating the restoration of the species at Badlands by tracking the genetic makeup of the offspring, determining initial parasite loads of the introduced sheep, and identifying habitat use and movements of the new subpopulation. Results from this project will benefit bighorn sheep managers in desert and alpine environments throughout the western United States, Canada, and Mexico, particularly where populations are in need of restoration or supplementation. A wide variety of federal agencies, 13 western state wildlife departments, and three organizations committed to the welfare of wild sheep will be able to use the results in restoring bighorn sheep to suitable habitat throughout their historical range. ■

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Bighorn sheep at Badlands National Park had reached a "population bottleneck." In September 2004, park staff and partners released 23 Rocky Mountain bighorn sheep from Wheeler Peak, New Mexico, to improve genetic diversity of the Badlands herd. Ten introduced ewes successfully lambed in spring 2005.

In order to monitor introduced bighorn sheep at Badlands, biologists fit the adults and yearlings with radio collars. As of June 2005, all the introduced bighorn sheep and 9 of 11 of the yearlings born in the park were alive.

Klondike Gold Rush National Historical Park ensures success of the region's first wetland restoration project

By Meg Hahr

YEARS OF UNRESTRICTED VEHICLE AND HORSE TRAFFIC had significantly impacted a 1-acre (0.4 ha) wetland area known as Nelson Slough near the historic town site of Dyea, Alaska, today part of Klondike Gold Rush National Historical Park. From the 1950s through the late 1990s, local residents, visitors, and park staff forded Nelson Slough to reach the Taiya River tidal flats. Protection of the slough was identified as a priority in the late 1990s after the Alaska Department of Fish and Game documented the presence of salmonids in Nelson Creek and the importance of the slough's wetland complex as habitat for juvenile coho salmon (*Oncorhynchus kisutch*). Since that time, the park has worked with adjacent landowners to locate an alternate vehicle crossing and initiated a multiyear project to restore the slough in 2003. In 2005, park staff continued revegetation efforts, controlled nonnative plants, monitored project success, and met with local school groups to talk about wetland ecology.

The Nelson Slough wetland restoration project is the first of its kind in the region.

Today Dyea is a major archaeological site where visible remains of the gold rush include collapsed buildings, decaying wharf pilings, scattered artifacts, and the Slide Cemetery, where many victims of an 1898 avalanche are buried. The park was established in 1976 to preserve in public ownership historic structures and trails associated with the Klondike Gold Rush of 1898. Restoration of the slough not only enabled the park to protect aquatic resources but also allowed visitors to experience the history of the gold rush in a largely natural setting. In the late 1990s the park worked with state and local landowners to find an alternate route to the tidal flats, which resulted in the construction of a vehicle bridge downstream. Subsequently, the park built a narrow footbridge for hikers and closed the slough to horse tours because of concerns about poor water quality, invasive plants, and soil erosion.

In 2003 the park biologist used base funds to hire a local firm specializing in wetland and stream restoration to produce a restoration design for the site. In 2004 the park obtained approximately $20,000 from the NPS Water Resources Division to implement the restoration plan. The reconfiguration of the channel profile occurred over a two-day period and required large volumes of gravel and soil. Water quality monitoring was done before, during, and after the construction. Aquatic macroinvertebrates were also sampled at the site. Before work began, the inlet and outlet of the slough were fenced off and all fish were trapped and removed from the area so they would not be affected by construction activities.

Park crews transplanted wetland and upland plants from adjacent reference areas into the restoration site immediately after the reconfiguration of the channel. Revegetation efforts were carried out with the assistance of the Southeast Alaska Guidance Association, a work and training program for young adults. In the following year, very little mortality was observed for the approximately 200 native plants that were relocated to the site. However, the site was found to contain several species of nonnative upland plants. In 2005, park crews worked to control these nonnative plants by manually removing them. Native seeds were collected and planted at the site, which is subject to ongoing monitoring. An interpretive program began to take shape in 2005 when park biologists met with local school groups to talk about wetland ecology.

Years of unrestricted traffic had significantly impacted a 1-acre (0.4 ha) wetland area known as Nelson Slough at Klondike Gold Rush National Historical Park. Protection of the slough was identified as a priority in the late 1990s after the Alaska Department of Fish and Game documented the presence of salmonids in Nelson Creek and the importance of the slough's wetland complex as habitat for juvenile coho salmon.

In summer 2004 the park hired local contractors to reconfigure the slough. Construction activities occurred over a two-day period and required large volumes of gravel and soil. Before work began, the fish in the slough were trapped and removed from the area so they would not be affected.

Immediately following construction activities, park crews, with the assistance of the Southeast Alaska Guidance Association, transplanted wetland and upland plants from adjacent areas into the restoration site. Very little mortality was observed for the approximately 200 native plants that were relocated to the site.

By 2005 the site had begun to recover from restoration activities. Park staff worked to ensure the long-term success of the restoration by continuing to revegetate the area, controlling nonnative plants, and meeting with local school groups to talk about wetland ecology.

The Nelson Slough wetland restoration project is the first of its kind in the region. However, the Taiya Inlet Watershed Council, a newly formed interagency watershed stewardship partnership, has identified many similar areas in need of enhancement. The lessons learned at Nelson Slough may be valuable to other resource managers in other parts of the watershed in the future. With this in mind, park staff worked to ensure the long-term success of the restoration project in 2005. ■

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Disturbed lands reclaimed at Prince William Forest Park

By Jennifer Lee

VISITORS TO NATIONAL PARKS MAY EXPECT to experience pristine landscapes preserved and protected from human despoliation. However, at some parks they will find landscapes that are recovering from previous damage as the parks reclaim and restore them. The boundary of Prince William Forest Park in Virginia contains 18,572 acres (7,522 ha), of which approximately 1,500 acres (608 ha) are private inholdings occupied by small businesses and homes. The National Capital Region and Prince William Forest Park have been actively acquiring lands within the park boundary from willing sellers. Two acquisitions, the Thomas tract and the Bradford tract, are sites of a project funded in 2004 by the NPS Natural Resource Preservation Program–Disturbed Lands. Of the combined 41 acres (16 ha) of the two tracts, 26.8 acres (10.9 ha) were forested and appeared to have been undisturbed by the former landowners, but 14.2 acres (5.8 ha) were in need of reclamation.

[Reclamation included creating] a swale that would reconstruct the natural topography of the site, using adjacent topography and existing drainages to guide the design.

These areas had been "human-disturbed" and the natural topography and drainage had been altered. The Thomas tract had been used primarily for single-family dwellings. Trash left by the former occupants littered the site and approximately 5,000 tires had been illegally dumped. The Bradford tract had been used as an unpermitted landfill that contained concrete, asphalt, and other materials. It also had a trailer park, an apartment building, and two single-family houses. These landscapes were barren and experienced a great deal of runoff during storms, causing erosion and sending sediment into Quantico Creek, although surveys and baseline groundwater data did not indicate the presence of any contaminants on either site. Much of the surface was open and level, sloping gently to the south, and had been altered by fill or soils that had been graded. Several invasive species flourished there, including lespedeza (*Lespedeza cuneata*), Japanese stiltgrass (*Microstegium vimineum*), Japanese honeysuckle (*Lonicera japonica*), and multiflora rose (*Rosa multiflora*).

Prince William Forest Park resource management staff worked with Dave Steensen of the NPS Geologic Resources Division to prepare an implementation plan for the reclamation of this land in 2004. This plan involved assessing the site and developing a task list of needed reclamation work. Planning also entailed conducting cross-sectional volumetric surveys to map the geometric shape of a swale that would reconstruct the natural topography of the site, using adjacent topography and existing drainages to guide the design. The contract for the work was awarded at the end of 2004. Before these plans could be implemented, park staff and volunteers removed more than 3,000 tires and several hundred pounds of trash;

Volunteers assist Prince William Forest Park staff in removing tires from the former Thomas tract. Before reclamation, parts of this tract had been used as a dump.

All trash, buildings, and concrete and asphalt rubble were removed and a swale was constructed to restore historical drainage. The project also included treating invasive vegetation and planting native grasses and trees. This photo shows the Bradford tract after reclamation.

one well was capped; one remaining structure was removed, which included asbestos abatement; and nonnative plants were treated.

Initial reclamation was completed in the summer of 2005 and included removal of more trash, concrete, asphalt, and all remaining structures; regrading the terrain; and restoring historical drainages by creating the swale with approximately 5,000 cubic yards (3,825 cu m) of compatible material obtained from a local construction site. Staff planted native grasses and 120 native trees, including red maple (*Acer rubrum*), river birch (*Nigra betula*), tulip poplar (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), pin oak (*Quercus palustris*), and sassafras (*Sassafras albidum*).

Over the next five years, permanent photo points will be used to monitor the progress of the reclamation efforts, and interpretive information will be developed highlighting the success of the project and the need for disturbed-lands restoration. These areas will never be pristine, but as a result of this reclamation, natural hydrology and native vegetation with accompanying animal life are returning. ■

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Fort McHenry and partners restore wetlands and invite the public

By Greg McGuire

THE WETLANDS ADJACENT TO FORT MCHENRY National Monument and Historic Shrine (Maryland), where major restoration efforts were initiated in 1997, continue to evolve with the assistance of the National Aquarium in Baltimore and the Maryland State Port Administration. In 2004 the State of Maryland spent $250,000 to improve the hydrology of the area, resulting in a dramatic increase in plant and animal life.

The project involved cutting three inlets through the existing riprap and constructing a network of tidal channels in the marsh to promote regular, natural tidal flooding. The National Aquarium in Baltimore and the Maryland Port Administration cooperated in developing the design with assistance from the National Park Service. The reconstruction was needed because three small culverts, built in the 1980s, had filled with silt, largely cutting off tidal exchange and resulting in several deleterious effects to the wetland. Primary among these were invasion and colonization by common reed, *Phragmites australis*. The clogged culverts also prevented the juveniles of migratory fish species, including striped bass, perch, and herring, from using the site as nursery habitat. After reconstruction, the aquarium and volunteers planted more than 50,000 native plants throughout the site. More recently the state has followed up by removing the phragmites.

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Many educational programs now take place on and around the marsh. Aquarium staff developed the AquaPartners program with Baltimore City Elementary Schools. Staff conducts nature walks with schoolchildren, teaching them about marsh ecology, the importance of wetlands, effects of stormwater pollution, and other environmental issues. In another program the aquarium partners with the Maryland Sea Grant to raise striped bass at local schools and release them in the wetlands at the end of the school year. The aquarium also maintains a demonstration aquaculture system adjacent to the wetland to raise striped bass. Fort McHenry provides a tour of the historic Star Fort for school groups. Over the past three years of the program, more than 3,300 students from 11 city schools have visited the park.

Members of the Baltimore Bird Club monitor bird populations and migration patterns daily and have observed 234 species, including bald eagle and rarities such as western kingbird, ash-throated flycatcher, and Asian black-throated gull. This

bird list represents a remarkable 55% of all bird species observed in the state of Maryland. White-tailed deer, beaver, muskrat, and a breeding pair of red fox have also been seen at the site.

An advanced, automated system, the YSI 6600 data logger, monitors water quality. Every 15 minutes this instrument measures dissolved oxygen, salinity, temperature, turbidity, pH, and chlorophyll at a site just west of the wetland. The aquarium partners with the Maryland Department of Natural Resources (DNR) on this project. The monitoring data are later displayed on the DNR's Web site.

This year Fort McHenry was awarded a $25,450 grant from the National Park Foundation through the Unilever Recycling at Work Program to construct two pedestrian footbridges in the wetlands to traverse the open canals. This will enable the national park to provide additional educational programs and species monitoring of the area. Expanding access to the site will allow additional groups to study, understand, and enjoy the natural resources flourishing here as the salt marsh is restored. ■

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With the assistance of the National Aquarium in Baltimore and the Maryland State Port Administration, the Fort McHenry tidal wetlands were reconstructed in 2004 (shown before restoration, left) to improve hydrology and eradicate phragmites, an invasive reed, resulting in a dramatic increase in native plant and animal life (shown after restoration, right). Since 1997, park staff has worked with partners and volunteers on quarterly cleanups to remove trash and debris. Educational programs provide opportunities for schoolchildren to learn about marsh ecology, pollution, and other environmental issues.